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MPA Materials Matter

Fall 2021

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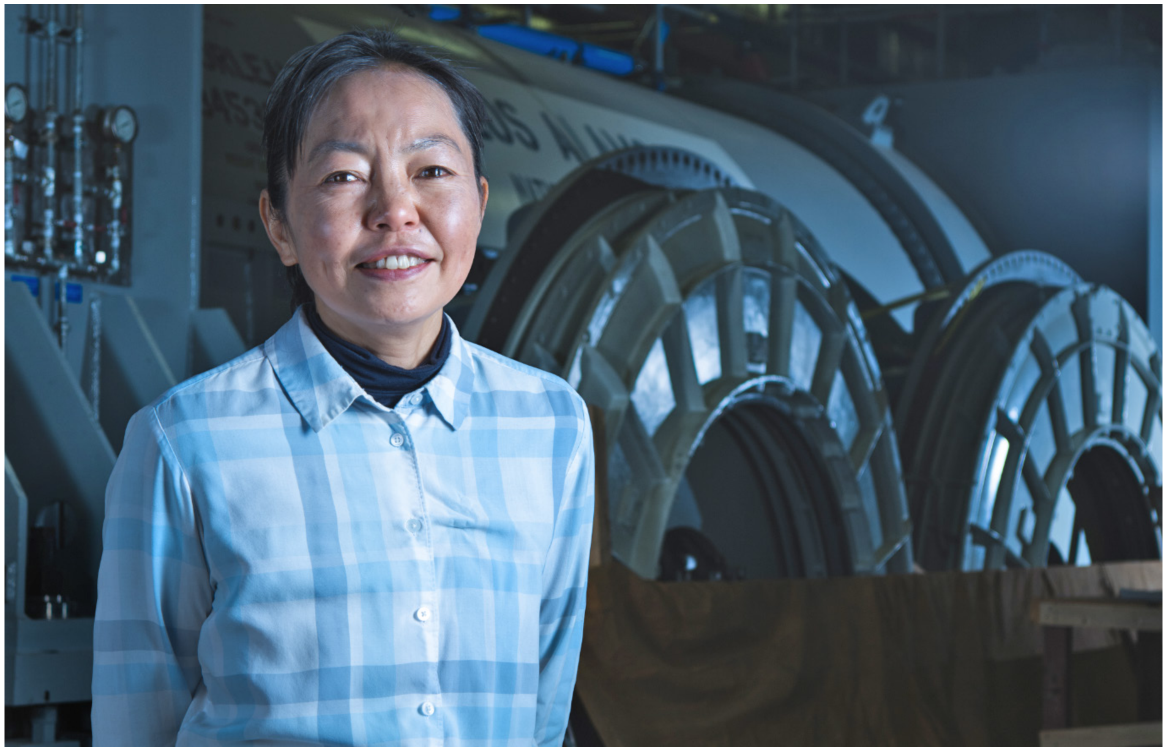
INSIDE

Los Alamos National Laboratory



Hazuki Teshima

Composing acts of engineering in support of magnet science

"I am in the world of great creativity and ask myself all the time what I can do for this world."

Hazuki Teshima never imagined having a career in science. Growing up in Japan as part of family that tended rice fields, she said, "I only ever saw scientists on TV!" As a lover of music and the visual arts, Teshima chose biology as her college major because the cover of the textbook was "so beautiful."

Now, as a generator operator at the National High Magnetic Field Laboratory-Pulsed Field Facility (NHMFL-PFF), Teshima is a maestro at directing complex works of engineering used to produce cutting-edge science with high magnetic fields. With unique pulsed magnets and experimental capabilities, the NHMFL-PFF specializes in materials science at the highest possible magnetic field intensity. The facility attracts researchers from around the world who use these tools and measurement techniques for fundamental and national security science.

"Human creativity at the maglab is a form of art," Teshima said, referring to the inquisitiveness and inventiveness of the facility's

continued on page 4

From Mike's desk . . .

> "I am excited for the opportunity to help the Lab in this new role and feel that it will give me a chance to gain a broader perspective."

This is my first week as acting deputy division leader and a good time to introduce or re-introduce myself to all of you. I am excited for the opportunity to help the Lab in this new role and feel that it will give me a chance to gain a broader perspective.

The bio below covers the usual stuff. Here are a couple of things to help you know me a bit better.

Years ago when I was leaving the Air Force for graduate school in physics, a friend challenged me over the phone with the one-word question, "Why?" My immediate response was, "I love science." My older brother thinks I became a physicist at age 10. He's probably right. Maybe it was inevitable I wound up at a national laboratory.

My view is that LANL needs people and organizations that simultaneously contribute to both basic research and mission science. I think that should be us. Getting our balance right and doing it the right way for MPA is part of what we have to manage. Some of you are individually or in a small team trying to keep at the 50-50 point. That's really, really hard. I know from experience, but also feel that we need people willing to give it a go, with management there to make it easier and sustainable.

Until this week, my three years in MPA have been in the maglab. I can get really excited about the maglab and all the awesome things we do and the great science, but my next challenge is to learn about the rest of the division. I'm not starting from scratch here, but want to fill in the gaps, understand the issues, and get to know all of you better so I can do my part well.

Best regards,
Acting MPA Deputy Division Leader Mike Rabin

Michael W. Rabin is the acting deputy division leader of the Materials Physics and Applications Division (MPA) at Los Alamos National Laboratory (LANL). Until recently, he was director of the Pulsed Field Facility, LANL's part of the US National High Magnetic Field Laboratory, a national user facility supported by the National Science Foundation. Prior to joining MPA and the maglab, Mike worked in LANL's Intelligence and Space Research Division, where he served as a senior project leader. He led LANL efforts for the development, launch, and on-orbit testing of four advanced technology CubeSats and related ground systems. In 2005, Mike started LANL work on the development and application of low-temperature detectors (LTDs) for a wide range of applications, from treaty verification to neutrino mass measurement to x-ray science. Low temperature here typically means 0.05–1K, with detectors based on quantum electronic devices and superconducting materials. With sustained effort over about a decade, he and his colleagues grew the Lab's LTD R&D capability, establishing LANL as a world leader for ultrahigh-resolution spectroscopy of radioactive and nuclear materials. Prior to joining LANL 18 years ago, Mike worked at the University of Colorado and the National Institute of Standards and Technology in Boulder, Colorado. He earned his PhD in condensed matter physics from the University of Illinois, Urbana-Champaign, in 1998, and his AB in physics from Cornell University in 1988. At heart, Mike is a scientific instrument builder with a love of precision measurement and passion for pushing the envelope of technical performance. Mike is a disabled veteran. For his active duty military service as a nuclear materials analyst and group leader in the Air Force Technical Applications Center (1990-1994), he was awarded the Meritorious Service Medal. Mike is author or coauthor of more than 70 scientific and technical publications. He has served in various roles for LANL engagement with US government agencies, international partners, and university consortia focused on basic nuclear science and nonproliferation.

From Steve's desk . . .

Potential collaboration opportunities can be missed because people in different fields talk past each other using language the other doesn't understand. In addition, it can create safety risks."

For the first two thirds of my career at Los Alamos, I spent most of it in essentially one place working on similar science and technology. However, over the decade since, I've had the privilege of contributing, in my small way, to programs outside of my main field of expertise in different parts of the Laboratory. Generally, this has been a very positive and interesting experience as I've been exposed to fascinating science and technology of which I was often unaware. At the same time, though, I've also been subject to a plethora of acronyms, slang, assumptions, and other forms of communication specific to a scientific specialty, or a LANL sub-culture, that can often be frustrating and confusing.

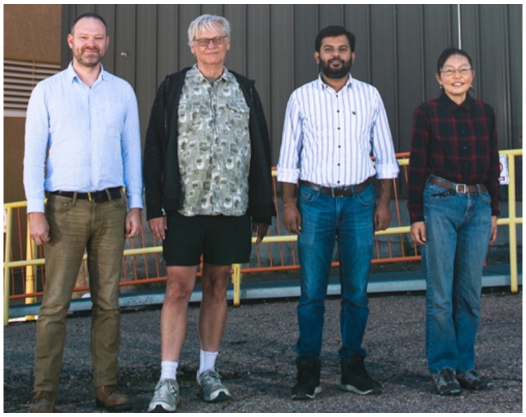
I think we all know that scientists communicate with each other in a way that is not generally accessible to non-scientists. We tend to speak in a shorthand specific to our field of study that we spend years learning. I have attended many scientific and technical talks outside my particular field of expertise where a steady stream of unfamiliar terms and assumed knowledge has made it quite impossible to follow the overall message of the presenter. And it is not just scientists who do this. We as a Laboratory speak among ourselves in a way that tends to be inaccessible to those not in the know, as evidenced by the website that houses the gigantic list of acronyms used at LANL: int.lanl.gov/projects/acronyms/acronym/index.

This can be a real problem, in my opinion, as it gets in the way of clear communication. Potential collaboration opportunities can be missed because people in different fields talk past each other using language the other doesn't understand. In addition, it can create safety risks. Does someone new to LANL know when told to call 7-2400 during an emergency that this really means 667-2400? (And now also requires the area code 505 if using a cell phone.) In a real-world example, a student in my group called a LANL phone number trying to get help and was directed to a pager where they were greeted by the standard "leave a numeric message." We all assume that everyone knows what this means, but the truth is many don't. In this case, the student did not know to punch in their phone number, but instead entered their Z number and did not receive the help they needed. This turned a likely benign event into something much more serious.

What I would encourage, then, is that we all try to be more cognizant of our audience. Is this person who I am presenting results to in my field of study? If not, how can I make my talk more accessible? If someone is new to the Lab, are you communicating to them in a way that does not assume a multiyear career at LANL? For my part, I explain to those new to my group how we came to shorten our phone numbers to five digits, introduce them to pager technology, and generally try to give them a crash course in LANL-speak. However, given the large number of people fresh to this Laboratory, I think reverting to clearer language among ourselves is something where we can all improve.

MPA-11 Group Leader Steve Russell ■

Teshima cont.



Hazuki Teshima (far right) and teammates (from left) Josiah Srock, Jeffrey Martin, and Ashish Bhardwaj.

staff and its users. The results of these efforts are "beautiful in their own way too."

A masterful conductor

As a research technologist on the NHMFL-PFF Power Team, Teshima ensures that the facility's massive 1.4-megawatt motor-generator system performs seamlessly when commanded. "Our magnet pulse test methods are unique and the generator is operated in a very particular way for that purpose," she said. "Knowing the right operation method and maintenance for this unusual system is challenging."

The stakes are high. With high intensity magnetic fields pulsing through magnet components in mere microseconds, most experiments are over in a heartbeat. Yet the work conducted at the maglab can have long-lasting scientific impact.

To ensure these results, Teshima maintains a constant vigilance—from analyzing computer-generated instrument stats to physically inspecting the facility's infrastructure and environmental conditions.

Currently she and her team members are working on several projects modernizing the maglab's infrastructure, enabling it to deliver the power needed to stay atop a highly competitive international scientific arena. These include collaborating with industry subcontractors from General Electric on the generator and motor stator and the NNSA's Cooling and Heating Asset Management Program for the generator's cooling system.

"As the lead operator on the LANL motor generator Hazuki has one of the most challenging jobs I know of," said Team Leader Josiah Srock. "Her position requires consistent attention to detail, visualization of the interconnected effects in a system that spans five buildings, technical expertise, and complex problem solving every day. She consistently delivers in all these areas and more."

Thriving in a creative, learning environment

Teshima joined the Lab as a postbaccalaureate student performing genome studies in Bioscience Division and transitioned to staff before joining the magnet lab in 2014. She credits prior operators Darrell Roybal and Yates Coulter with providing the training necessary to learn the ropes and her current teammates Srock, Ashish Bhardwaj, Jeff Martin, and Richard Herrera and her colleagues with "each having such a rich knowledge and giving me innovative ideas and suggestions."

"My strength is that I don't hesitate to ask questions. I want to be learning all the time," Teshima said, adding that she is proud to be part of a team of continuous learners. The Lab "is a unique place, open to all types of people and backgrounds," Teshima said. She considers herself lucky to work with "true professionals who enjoy their work to improve the world of their interest" and who generously share their knowledge with her. "I am in the world of great creativity and ask myself all the time what I can do for this world." While, her impact on the world is small, she said, "I am trying to make it a positive impact."

By Sarah Wallstrom, CEA-CAS

Hazuki Teshima's favorite LANL experience

What: Generator-rotor removal

Where: Generator facility at the National High Magnetic Field Laboratory-Pulsed Field Facility

When: Summer 2019

Why: The big generator rotor was moved out from the generator—in front of me. A lot of LANL staff and subcontractors were working together in our building, where there are usually only a few people. I also understood that there were a lot of workers behind this scene. This job was an art of work-together and allowed me to visualize what teamwork was and why it was important.

Who: Maglab staff, the LANL generator maintenance project team, and subcontractors General Electric and Barnhart.

The "a-ha" moment: Every moment during this job was my once-in-a-lifetime experience. There were so many "a-ha moments" in this job: when the generator rotor on the Goldhofer trailer was moved out from the generator building; when the subcontractor operated the trailer and made the very tight turn without struggle—it was a stunning job. Installing the new rotor and commissioning the generator will be challenging work. The next generator-driven magnet pulse test at the maglab will be my BIGGEST "a-ha moment."

Unlocking the potential of lithium-ion batteries by understanding silicon failure

In silicon-wire lithium-ion batteries, electrolytes carve away the silicon, blocking electron pathways and greatly diminishing the charging capacity of these promising devices.

Work published in *Nature Nanotechnology* identifying that process opens fresh research avenues for harnessing silicon's potential to revolutionize high-capacity, long-lasting batteries for everything from cell phones to automobiles.

"With this new understanding, we propose to improve silicon nanowire lithium-ion battery performance by developing a coating approach that isolates the silicon from the electrolyte," said Jinkyoung Yoo (Center for Integrated Nanotechnologies, MPA-CINT), a staff scientist and corresponding author on the paper.

The research, by collaborators with national laboratories and universities, integrated sensitive elemental tomography, cryogenic scanning transmission electron microscopy, and an advanced analysis algorithm to reveal in 3D the correlated structural and chemical evolution of silicon and the solid-electrolyte interplay (SEI) that forms in all batteries and makes them work.

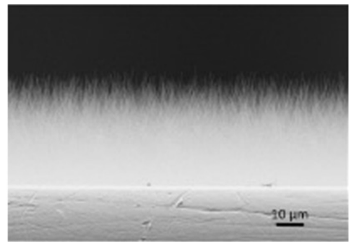
Yoo grew a "forest" of silicon nanowires on a stainless steel disk as the anode for the battery experiment. The Los Alamos CINT facility has a unique capability for growing this kind of silicon wire directly on an anode.

Industry and national laboratory researchers consider silicon to be the most promising high-capacity anode material for practical application in next-generation lithium-ion batteries. Batteries comprise anodes, which bring electrons in, and cathodes, which move them out to create current.

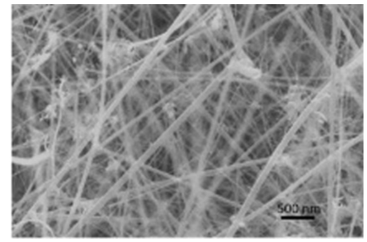
Using graphite-based anodes, lithium-ion batteries have enabled long-lasting cell phones and electric vehicles with more than 400 miles of driving range. Developing the next generation using silicon anodes—known to have 10 times the storage capacity than batteries with graphite anodes—has been stymied by fading capacity after repeated charging. After 100 charging/discharging cycles, a battery using silicon can only manage 60% of its original storage capacity—not good enough for everyday technology. Until now, no one knew exactly why.

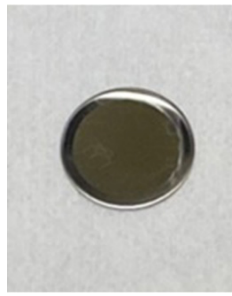
In early applications, when silicon spherical particles were exposed to the electrolyte and charged, they expanded 300% and destroyed the anode. In all types of batteries, that process of exposing the anode to the electrolyte creates a reaction that forms the SEI, which is essential for electrochemical reactions in batteries and critically governs battery stability.

Side view



Top view





Photos of silicon nanowires grown on a stainless steel disk shown (clockwise from top left) in side, top, and macroscopic views. The disk is about the size of a quarter. New research in *Nature Nanotechnology* has discovered the processes that have limited use of silicon in lithium-ion batteries and has identified a research path to overcome them. Batteries with silicon anodes have 10 times the electrical storage capacity of batteries with typical graphite-based anodes.

When the SEI detaches from the anode, as it does with silicon, electrical contact breaks and battery capacity goes down. "We had once thought that nanowires would solve the problem of silicon expanding in the electrolyte, because a wire can stretch in length, but it turns out we didn't understand what is happening," Yoo explained.

The new research found that the electrolyte penetrates silicon everywhere, forming pockets of SEI that disrupt electron pathways, Yoo said. This process disconnects isolated islands of silicon in the anode that cannot contribute to battery capacity. Yoo said the next step is to coat a silicon particle or nanowire to preserve the integrity of the silicon in the presence of the electrolyte.

Reference: "Progressive growth of the solid-electrolyte interphase towards the Si anode interior causes capacity fading," by Yang He, Yaobin Xu, Chongmin Wang, Haiping Jia, Ran Yi, Xiaolin Li, Ji-Guang Zhang, Miao Song (Pacific Northwest National Laboratory); Lin Jiang, Arda Genc, Cedric Bouchet-Marquis, Lee Pullan, Ted Tessner (Thermo Fisher Scientific); Tianwu Chen, Dingchuan Xue, Sulin Zhang (Pennsylvania State University); and Jinkyoung Yoo (MPA-CINT), *Nature Nanotechnology* 16 (2021).

The DOE BES Scientific User Facilities Division funded the work, which supports the Lab's Energy Security mission area and Materials for the Future science pillar.

Technical contact: Jinkyoung Yoo

Lab and Pajarito Powder complete one of the first New Mexico-funded fuel cell projects

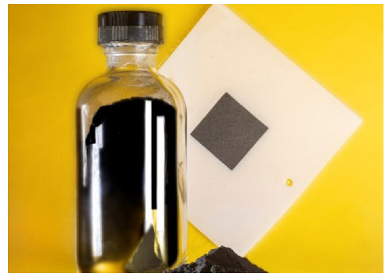
Initiative provides support to New Mexico business

As part of New Mexico's TRGR Readiness Initiative, the Laboratory and Pajarito Powder have completed a project that will help improve hydrogen fuel cells.

"Through the TRGR Readiness Initiative, we have been able to support Pajarito Powder by performing a suite of tests that improve the understanding of how their catalysts perform, and how they can further advance their product development," said Rod Borup (Materials Synthesis and Integrated Devices, MPA-11). Borup is Los Alamos's Fuel Cell Program manager and principal investigator on the Million Mile Fuel Cell Truck initiative.

The TRGR initiative addresses the gap of knowledge transfer and technology advancement when a New Mexico business licenses a laboratory technology or engages in a research partnership. Companies, such as Pajarito Powder, gain the opportunity to work directly with scientists and engineers at Los Alamos to accelerate their technologies past the invention stage into products. For this project, the Laboratory evaluated fuel cell catalysts designed by Pajarito Powder to better understand the drawbacks of current catalyst technology.

A fuel cell uses the chemical energy of hydrogen to produce electricity. In a hydrogen fuel cell, a catalyst at the anode separates hydrogen molecules into protons and electrons, which take different paths to the cathode. The electrons go through an external circuit, creating a flow of electricity.



Through the TRGR initiative, New Mexico businesses such as Pajarito Powder work with scientists and engineers at Los Alamos to accelerate their technologies. Photo credit: Pajarito Powder

Through the Laboratory's analysis, fuel cell durability of Pajarito Powder's electrode catalyst showed minimal loss in performance after tests designed to mimic degradation over a life time of heavy duty transportation applications. The tests also helped identify how catalyst degradation happens, which will aid Pajarito Powder in the development of a new generation of fuel cell catalysts to surpass current performance required by applications and customers worldwide.

"Fuel cells offer a cleaner way to produce electricity, and could one day be used to power transportation vehicles," said Barr Halevi, co-founder of Pajarito Powder. "Ultimately, this technology could help significantly reduce CO_2 emissions worldwide."

Technical contact: Rod Borup

MPA staff in the news

Derby recognized for Science in '3' presentation

Ben Derby (Center for Integrated Nanotechnologies, MPA-CINT) was recognized as an outstanding presenter in the Lab's Science in "3." In the career development event organized by the Postdoc Program Office, Lab postdoctoral researchers present their research for a general audience in three minutes or less, challenging the postdoc to give a clear and concise presentation.

Derby's presentation, "4D microscopy: A tool to understand and optimize materials," described how he and his colleagues use radiation to knock around atoms, change their relative arrangement, and determine how that impacts the material. To see these atomic rearrangements, they use a novel microscopy technique to observe changes in the material in four dimensions. The technique not only assists in understanding complex oxides as Derby presented here, but also allows researchers to understand and manipulate materials in scientific fields as far ranging as biology and nuclear materials science.

The Director's Postdoctoral Fellow uses advanced electron microscopy to understand the coupled extremes of corrosion and irradiation in metallic and oxide materials. He is mentored by Nan Li (MPA-CINT); Courtney Kreller (Materials Synthesis and Integrated Devices, MPA-11); and Matt Janish (Nuclear Materials Science, MST-16). Derby has a PhD in materials science and engineering from the University of Michigan.

Technical contact: Ben Derby

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MPA staff cont.

Komini Babu receives ECS Toyota Young Investigator Fellowship

Siddharth Komini Babu (Materials Synthesis and Integrated Devices, MPA-11) has received an Electrochemical Society (ECS) Toyota Young Investigator Fellowship for Projects in Green Energy Technology. The $50,000 fellowship supports young electrochemical researchers as they develop battery and fuel cell technology, including research topics that may result in further technological innovation. It is offered by the ECS and the Toyota Research Institute of North America, a division of Toyota Motor Engineering and Manufacturing North America.

Komini Babu's proposal for the fellowship investigates the role of gas diffusion layers (GDLs) and microporous layers (MPLs) on the durability of polymer electrolyte fuel cells. Components in the fuel cell system can corrode during operation, which leads to metal contaminant ions eventually being transported into the fuel cell electrode through the GDL and the MPL. These ions cause severe degradation in the fuel cell, reducing the device lifetime. Komini Babu's work focuses on developing a GDL architecture that can increase fuel cell durability by suppressing or eliminating the transport of these contaminants. He also aims to improve long-term operational durability of GDLs and MPLs by tailoring them separately for the negative (or anode) and the positive (or cathode) side of the fuel cell, where the chemical energy of the fuel (hydrogen) and oxidizer (oxygen) is converted to electrical energy. Improved fuel cell durability is an important development for sustainable energy conversion used in a variety of applications, from transportation to stationary energy generation.

Graduating from Carnegie Mellon University with a PhD, Komini Babu conducted postdoctoral work at Los Alamos from 2016-2019 before becoming staff scientist. He is the author of more than 25 articles and has four patent applications.

In addition to the monetary award, fellowship recipients receive a one-year complimentary ECS membership, the publication of their findings in an open-access ECS journal, presentation on the findings in an ECS meeting, plus the possibilities of a research agreement with Toyota.

Technical contact: Siddharth Komini Babu ■

MPA staff recognized with R&D 100 Awards

Technologies that provide a novel approach to electric grid security and that revolutionize fieldable nuclear magnetic resonance analysis of solids or liquids have been recognized with 2021 R&D 100 Awards.

Developed by Los Alamos researchers and collaborators, "Quantum ensured defense for the smart electric grid" (QED) uses single light particles (photons) to create cryptographic "keys" that "lock" control signals into secret codes to protect the electric grid from third-party infiltration. Current security systems rely on mathematical complexity, but QED applies the unusual behavior of the quantum realm to protect electric grid control signals from third-party infiltration. Los Alamos and Oak Ridge national laboratories demonstrated scalable, plug-and-play, systems-level cybersecurity on EPB's commercial, metro-scale electricity distribution network in Chattanooga, Tenn. Raymond Newell (MPA-Quantum, MPA-Q) led the Los Alamos team of Claira Safi (Space Data Science and Systems, ISR-3) and Justin Tripp (Information Sciences, CCS-3).

Receiving an R&D 100 Award and a silver special recognition for market disruptor products was "Earth's-field resonance detection and evaluation device" (ERDE). ERDE is a magnetic resonance spectrometer that uses the Earth's magnetic field for rapid, accurate, and safe identification of

Technology providing a novel approach to electric grid security has been recognized with a 2021 R&D 100 Award. Developed by Los Alamos researchers and collaborators, "Quantum ensured defense for the smart electric grid" uses single light particles (photons) to create cryptographic "keys" that "lock" control signals into secret codes to protect the electric grid from third-party infiltration. Here, Claira Safi (Space Data Science and Systems, ISR-3) and Raymond Newell (MPA-Quantum, MPA-Q) verify system performance prior to a field test with partners at Oak Ridge National Laboratory and EPB, an electric power utility in Tennessee.

continued on next page ▶

MPA staff cont.

chemicals. MPA-Q's Per Magnelind was a member of the team that included Derrick Kaseman, Bob Williams, and Jacob Yoder (Bioenergy and Biome Sciences, B-11); Michelle Espy (Non-destructive Testing and Evaluation, E-6); Algis Urbaitis (formerly Materials Physics and Applications, MPA-DO); Michael Janicke (Inorganic Isotope and Actinide Chemistry, C-IAAC); and Scarlett Widgeon Paisner (Materials Science in Radiation and Dynamics Extremes, MST-8).

The Laboratory also received an R&D 100 Finalist Award for "Integrated chutes and sensors." Created by LANL in tandem with Jenike & Johanson, the technology uses integrated acoustic moisture sensors to improve the operational reliability of biorefineries. Troy Semelsberger and Cristian Pantea (both Materials Synthesis and Integrated Devices, MPA-11) led the team of Eric Davis, Hung Doan, John Greenhall, Christopher Hakoda, Craig Alan Chavez, and Pavel Vakhlamov (MPA-11).

The R&D 100 Awards honor the latest and best innovations and identify the top technology products of the past year. Since 1978 the Lab has won more than 178 R&D 100 Awards. The Laboratory's discoveries, developments, advancements, and inventions make the world a better and safer place, bolster national security, and enhance national competitiveness.

Technical contacts: Raymond Newell, Per Magnelind ■

Inclusivity tip

Take a minute to update your email signature to include your personal pronouns. This is a simple and easy way to make everyone feel comfortable and included. For the template and updates, visit the Lab's template downloads page.

HeadsUP!

Returning administrative keys

A worker must return all administrative (Level IV with a LANL series number) keys to the appropriate lock and key custodian when he or she no longer requires use of the key (e.g., when transferring to a new organization or a new office, retirement).

When an administrative key is returned to the appropriate lock and key custodian, its status will change from issued to received and an email receipt will be sent to the individual returning the key.

Another option is to return the key to the lock and key office, located in TA-3, Building 0495. After a team member receives the key, he or she will contact the appropriate custodian for the key "series." The key will remain assigned to the individual until the custodian physically receives it and updates the status from issued to received.

Celebrating service

Congratulations to the following MPA Division employees celebrating recent service anniversaries:

Brian Scott, MPA-11	**30 years**
John Rowley, MPA-11	**20 years**
Darrick Williams, MPA-CINT	**20 years**
Benjamin Davis, MPA-11	**15 years**
Kevin Henderson, MPA-Q	**15 years**
Jacob Spendelow, MPA-11	**15 years**
Cortney Kreller, MPA-11	**10 years**
Stacy Baker, MPA-CINT	**5 years**
Jonathan Gigax, MPA-CINT	**5 years**

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To submit news items or for more information, contact Karen Kippen, ALDPS Communications, at 505-606-1822 or aldps-comm@lanl.gov.

To read past issues see www.lanl.gov/orgs/mpa/materialsmatter.shtml.

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